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ABSTRACT

This bulletin is a reprint of Part 3 of the College of Education, University of Georgia's proposal to the U.S. Department of Health, Education and Welfare, Office of Education (USOE) to undertake a feasibility study of the Georgia educational model (Johnson, 1969). It is a discussion of the theoretical considerations underlying procedures which were proposed to be used to carry out the USOE request for proposal specifications relative to cost estimation. Included are sections on "Control and Cost Estimation Related," "Management Technology," and "Approaches to Cost Estimation." Discussion of the systems approach includes depiction of the major relevant subsystems to be included in estimating and control: organization, communications, value, time, facilities, technology, product, dynamics, legal framework, and ethical and moral behaviors. (Author/JS)

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THEORETICAL CONSIDERATIONS FOR PROJECT COSTS

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Preface

This bulletin is a reprint of Part Three of the College of Education, University of Georgia's proposal to the U.S. Department of Health, Education and Welfare, Office of Education (USOE) to undertake a feasibility study of the Georgia educational model (Johnson, 1969). It is a discussion of the theoretical considerations underlying procedures which were proposed to be used to carry out the USOE request for proposal specifications relative to cost estimation (USOE, Oct. 31, 1968).

PART THREE

Cost Estimation

It is the purpose of this part of the proposal to describe procedures which would produce cost data in a form which makes possible rational consideration of alternates, dependent upon amounts of funds available, for the development and implementation of the model program. It should be evident from the information presented in Part Two that when the proposed numerous networks have been designed in detail, they will lend themselves to analysis in such a manner that cost data, relative to the various resources needed for each program component (i.e., student selection, behaviors, or development of learning materials) through each phase of the program (i.e., preprofessional, professional, specialist) and through each phase of program development (i.e., design, planning, developing, piloting, phasing-in, implementing) may be estimated at its maximum, norm, and minimum. These data might then be stored in computer data banks for retrieval at a later date when cost estimates for alternate paths of action are desired. Such a procedure of data storage and retrieval, if implemented in accord with the principles set down in this part of the proposal, would make it possible to estimate the cost of development and operation of the program (or selected components of the program) at other intitutions which may vary in size, location, and organization. Also, such an approach would provide procedures which, when longitudinal follow-up evaluation data are taken into consideration, would relate proper costs of the program components to program effectiveness.

Control and Cost Estimation Related

The design of the model program and that of the research and development strategy to effect its implementation are innovative; thus, it becomes necessary to

design a cost control subsystem for the feasibility study which covers the exigent nature of the operation. As regards the development of such a subsystem. control is emphasized because sophisticated cost estimation is futile without attendant control to maintain the integrity of the base on which the estimates are made. By control, it is intended that an exhaustive, reiterative network of all the primary and secondary components be structured. By the dynamic ordering of this network as the project progresses, a flexible working control can be maintained to provide information as to where effort must be applied or components shifted in order to accomplish the objectives within the budgeted money, time, and resources available. Variances in the original estimates to their true costs can be shifted within the network to take advantage of efficiencies and unforeseen difficulties. Routine reiterations of this sort will display parts that need corrective or creative attention as the project proceeds. It is expected that a dynamic improvement function will be built into the overall operation to solve the myriads of subproblems that cause a research and development exercise to become inefficient even if it does accomplish its overall mission. Therefore, it is imperative that control be an integral superfunction of any cost estimation exercise.

Management Technology

The necessity for designing an innovative control subsystem for estimating development, implementation, and operation costs does not preclude the use of standard management technology. However, from the outset, it is intended that this complementary control subsystem will in itself be a unique contribution to the overall model. This becomes an important subobjective in that the systems approach requires that all the parts of the design be compatible in their interaction.

Four sources of information will be used in designing the control subsystem. First, general accounting, cost accounting, standard budgeting, and forecasting methodologies are well developed historical approaches that seem suited for parts of the control process. Second, contemporary techniques such as Critical Path Scheduling, Network Analysis, Benefit-Cost Analysis, Systems Simulation, Computer Applications, and Linear and

Dynamic Programming are likely to be applicable either directly or with creative modification to fit the uniqueness of the requirements of this model. Third, research and development industries provide a rich environment for frontier activity and concepts that are as yet unpublished, particularly in areas of intense activity such as space and defense industries where new techniques for management controls are being developed. Also, on a few university campuses contributions to this new technology are emerging. From these several sources, new ideas are likely to be useful for the design. The fourth, and perhaps most important, part in the development of management control for this model is the design input. This capability has already been built into the staffing description. It is, also, reinforced as one of the expected corollary outputs of the overall program.

Approaches to Cost Estimation

As regards specific approaches to providing cost estimates, it is proposed that any scientific approach be available if needed so long as provision is made for its compatibility in its interaction with other approaches. Thus, fundamental to this management control subsystem is the alpha concept; that is, a seemingly hidden, but nonetheless real, objective is to develop a uniquely successful prototype. With this attitude toward comprehensiveness of concern and excellence of performance, the effort expended is much more likely to accomplish the obvious intent of the project. Also, it is intended that current operations research methodologies be employed, particularly those that involve mathematical modeling and computer applications. The individuals on the teams for this investigation have been deliberately chosen to complement each other so that the necessary skills will be available for the overall design. Furthermore, it is expected that these individuals will express inherently different points of view in their deliberations. This is precisely the kind of team effort that has been so successfully employed in the classical operations research method.

Although the systems approach is fundamental to the overall strategy, attention must first be given to the

functioning of the analytic method since it is basic to the utilization of the systems approach.

The Analytical Method

Throughout the design, test, and subsequent operation of the overall model. each major and minor subsystem and unit of the overall system will be subjected to separation, identification, articulation, and evaluation. From these analyses (before and after configuration of the units of the system), the goal of optimum design is more likely to be reached. It should be noted that the primary design objective, the model program itself, has as a theoretical base a parallelism with analytical methodology. In addition, contemporary management control systems are built and manipulated using subcomponents that can be measured and rearranged much like mechanical, electrical, or chemical processes of design. This approach to structuring and controlling a system is basic to the intelligent application of the new techniques and the new technologies such as computers. Therefore, from the very start, the prime system will be approached with a homogeneous design philosophy.

Systems Approach

To avoid specious varieties of the systems approach, it is intended that the design incorporate the best thinking from the philosophical, theoretical, structural, conceptual, and pragmatic aspects of the emerging systems methodology. The initial approach that is reflected in this proposal is structured on interlocking program components of the educational model as the prime product. This primary objective is supported by a number of structural subsystems for cost analysis as is shown in Fig. III-1 which provides a conceptual diagram depicting the major relevant subsystems to be included in estimating and control.

The power or control function. The power function is normally implied in the organizational subsystem. However, as conceived in this proposal, it has a specialized control function or an overall authority separate

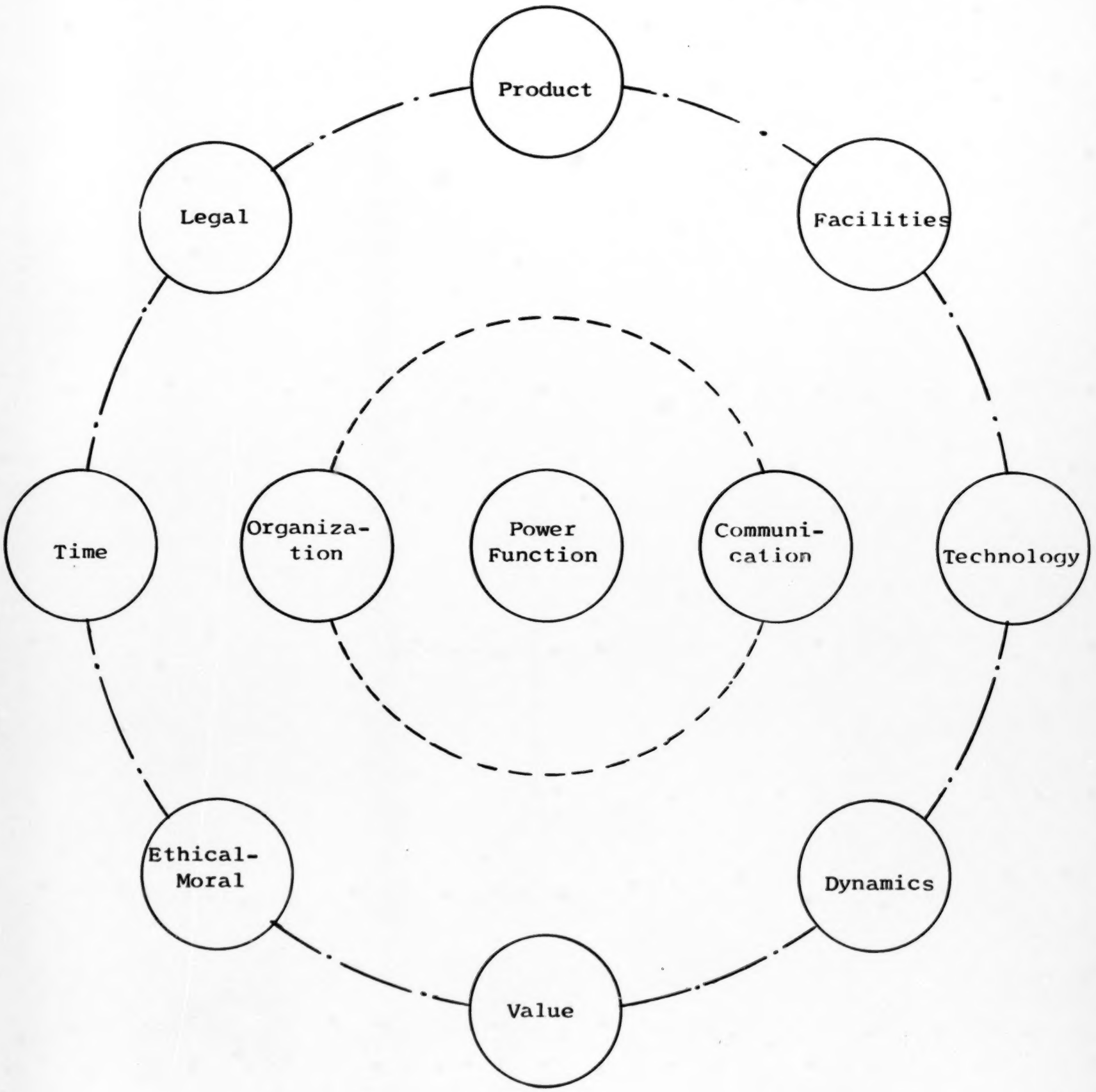

Figure III-1

A Conceptual Diagram Depicting the Relevant Subsystems to be Included in Estimating and Control

and distinct from the other subsystems. The organization and communication subsystems closely complement the power function. Since the power function inherently is the responsible intellectual nucleus of this program, it contains the authoritative thrust in order to close the systems loop in a meaningful manner. Recognition of this function is fundamental to estimating and controlling the behavior of the myrid of subunits that must be directed toward the final goal. Any gross malfunction in this subsystem disrupts the discipline necessary to the design and operation of a management control subsystem.

Organization. The configuration of the various people, machines, buildings, money, and communications into a meaningful working whole is the main thrust of the organizational subsystem. While there is some relationship to the standard notions of organizations of people, it is much more comprehensive because it configurates all the parts--people being only one of the parts. It is further concerned with a Gestalt-like effect that comes with an integrated system.

Communications. Parts of the system such as facilities, product, time, dynamics, and money must be superposed with a communications subsystem that links them all together in a meaningful way. This concept is usually best described with a subordinate network similar to electrical devices that relate and describe the functioning of complex mechanical systems. Within the communications network (or subsystem) there are likely to be system hierarchies.

Value. In designing and operating a system, each component should be able to produce an output more useful than its input. The notion that the overall system is functioning in an optimal manner is best approached by being concerned with the usefulness ratio of each part. Modeling of this part of the system is usually approached by giving each input and output value a numeric monetary assignment. It is the conceptual base for the application of techniques such as benefit-cost analysis, input-output analysis, critical path method, and others.

Time. In pragmatic systems modeling, the time function is a basic conceptual part. For example, by applying more money to parts of a design, the time vector can usually be shortened. Contrariwise, time can usually be added and less money used. Assimilating the time function into the overall model is usually coupled closely with the value function, but it is, also, the key part of coupling all the modes, components, and subsystems into an efficient working system.

Facilities. The facilities subsystem incorporates the physical parts of the system under numerous subheadings such as buildings, equipment, and supplies. Attention has been given to this concern throughout Part Two of this proposal, and Appendix C contains lists of typical facilities which might prove to be essential resources in any of the networks subjected to analysis and cost estimation.

Technology. A peculiarity of systems design pertains to the state of the art among the subsystems within the designs. The skillful designer must have keen insight into the state of development of each component in relation to the others as well as the classical past, present, and future of the design. For example, in this research traditional and futuristic educational methods and management methods must be carefully put together, tested, and evaluated. Therefore, it is proposed that each component be given an analytic evaluation for its state of technology.

Product. The educational model in its entirety is the expected output from this effort. An important subpart is the students who are trained by the model as exhibits of the pilot experiments.

Dynamics. The conceptualization, development, evaluation, and operation of the system on a real time scale is an inherent part of the model. The proposed management control system would incorporate the movement, the intrasystem dynamics, the subsystem interfaces in such a way that the overall model would be integrated on a real time basis. Traditional concepts such as scheduling, estimating, planning, production, and cost management would all be used, but in a dynamic system configuration.

Legal. It is expected that this systems design will be generated and used within the existing legal framework. However, investigation may reveal the need for lengthier negotiations than anticipated with state and other institutional organizations regarding such matters as certification, degree requirements, credit hours, grade point averages, class attendance time, tuition, scholarships, and costs for learning materials. In addition, there will be a normal amount of routine matters of a contractual nature that will need to be considered as the program progresses.

Ethical and moral. The overall goal of this enterprise appears well within accepted domains of ethical and moral behaviors. The basic viewpoint underlying the conception of the model program gave considerable attention to this aspect. However, concern for this subsystem is included here to exhibit thoroughness and to reassure the sponsors of the research that this subsystem will be given systematic treatment as an implicit part of the management control system.

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